

## Mathematics, Art and the Common Core

March 31, 2012

Region X Algebra Forum

Diane Kinch

<http://www.lacma.org/art/exhibition/mural-remix-sandra-de-la-loza>

## Urban Light



Credit: (Associated Press Photo/Rick Orloff)

## Math and the Visual Arts: Commonalities

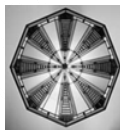
- Language
- Repetition
- Shapes/Plane Figures
- Forms/Space or Solid Figures
- Balance
- Perspective
- Proportion

## Common Skills

- Problem-solving skills
  - visualization
  - spatial reasoning
- An interdisciplinary approach to art and mathematics allows students to identify and apply authentic connections between the two subjects and understand concepts that transcend the individual disciplines.

## Parallels: The LACMA Collection

- Functional
  - table lamp composed of geometric shapes and intersecting lines designed by architect Frank Lloyd Wright.
- Complex and intricate patterns
  - the museum's 1880s-era quilt made by Pennsylvania Dutch women is an example
- Geometric concepts
  - the Laura Andreson (United States, 1902 - 1999) Bowl, 1938
  - the 15th century Iranian tile.



## The Language

- Lines
  - Lines can vary in width, length, curvature, color, or direction.
  - What types of lines do you see?
    - Are there horizontal, vertical, or diagonal lines?
    - Are some of the lines parallel or are they perpendicular or skew?



## California Design, 1930–1965: Julius Shulman Case House #22

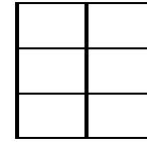


<http://www.lacma.org/art/exhibition/californiadesign>

- Standards of Mathematical Practice:
  - Look for and make use of structure
  - Look for and express regularity in repeated reasoning.
- 4th Grade
  - Geometry
    - Draw and identify lines and angles, and classify shapes by properties of their lines and angles.
      - Draw points, lines, line segments, rays, angles, and perpendicular and parallel lines. Identify these in two-dimensional figures.

## Task 1

A square has an area of 144 square inches. Suppose the square is partitioned into six congruent rectangles as shown below. How many inches are there in the perimeter of one of the six rectangles?



How is this problem connected to the standards of mathematical practice and content and to the photograph?

## Repetition



- Repetition is the recurrence of elements of art at regular intervals. When lines, shapes, and forms repeat in a predictable combination, they form a pattern.
  - Identify the artist's use of repetition.
  - What patterns do you see in this artwork?

## Tile: Greater Iran 15th century



- Standards of Mathematical Practice:
  - Look for and make use of structure
  - Look for and express regularity in repeated reasoning.
- High School
  - Geometry
    - Understand congruence and similarity using physical models, transparencies, or geometry software.
      - Verify experimentally the properties of rotations, reflections, and translations.

## Task 2

- How many lines of symmetry does the figure on the right have under each of the following conditions:
  - We take into account the patterns on the tile.
  - We only look at the tile shape, devoid of decorations.



How is this problem connected to the standards of mathematical practice and content and to the tile?

## Shapes/Plane Figures

- Shapes/Plane Figures are two-dimensional figures in which all points lie in the same plane.
- Shapes can be open or closed, free-form or geometric.
- What shapes or plane figures do you see in these artworks?



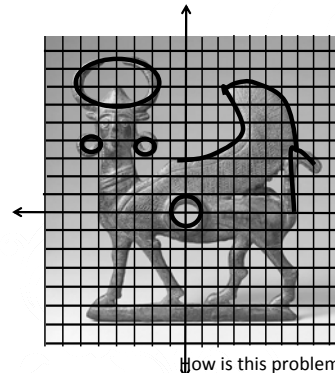
## Iran, Luristan

- Standards of Mathematical Practice:
  - Look for and make use of structure
  - Look for and express regularity in repeated reasoning.
- High School
  - Geometry
    - Expressing Geometric Properties with equations.
      - Translate between the geometric description and the equation for a conic section



[http://www.lacma.org/sites/default/files/image/neareastmain\\_0.jpg](http://www.lacma.org/sites/default/files/image/neareastmain_0.jpg)

## Task 3



- Define the circles at the left in terms of the following:
  - The definition of a circle as a plane figure.
  - The definition of a circle as a conic section.
  - The definition of a circle as a form on a sphere
- If the question were for the ellipse, what would have to change? Why?

How is this problem connected to the standards of mathematical practice and content and to the statue?

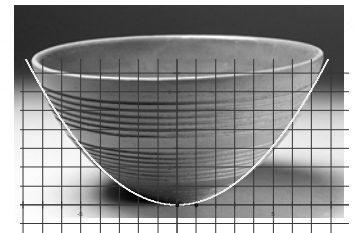
## Forms/Space or Solid Figures



- Forms/Space or Solid Figures are 3-dimensional (having height, width, and depth), enclose volume (or mass), and help us to understand physical space.
  - For example, a triangle, which is 2-dimensional, is a shape. But a pyramid, which is 3-dimensional, is a form.
- Cubes, spheres, pyramids, cones, and cylinders are examples of forms.
- What forms or solid figures do you see in the artworks?

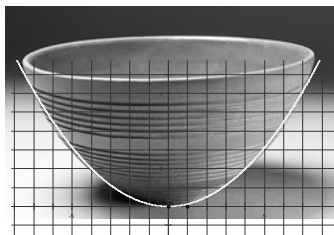
Laura Andreson  
(United States, 1902 - 1999)  
Bowl, 1938

- Standards of Mathematical Practice:
  - Model with Mathematics
- High School
  - Calculus
    - Students use definite integrals in problems involving area, velocity, acceleration, volume of a solid, area of a surface of revolution, length of a curve, and work.



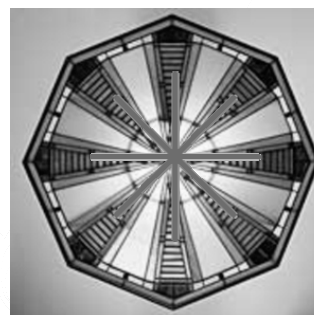
## Task 4

- Determine the volume of the solid of revolution pictured at the right.



How is this problem connected to the standards of mathematical practice and content and to the bowl?

## Balance



- Balance is the arrangement of elements to create a sense of equilibrium and harmony.
- Types of balance—
  - Symmetry
  - Asymmetry
  - Radial symmetry

FRANK LLOYD WRIGHT (U.S., 1867–1959)  
Table Lamp from the Susan Lawrence Dana House,  
Springfield, Illinois, 1902–4

- Standards of Mathematical Practice:
  1. Make sense of problems & persevere in solving them.
  2. Reason abstractly & quantitatively
- 4th Grade
  - Geometry
    2. Classify 2-dimensional figures based on the presence or absence of parallel or perpendicular lines, or of angles of a specified size.
    3. Recognize a line of symmetry for a 2-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.



<http://collectionsonline.lacma.org/mwebcgi/mweb.exe?request=record;id=12>

## Task 5

- All of the triangles on the right are similar. If the altitude of the largest triangle is 20 cm and its base is 5 cm, and the constant of proportionality is  $\frac{4}{5}$  what is the area of the smallest triangle?



How is this problem connected to the standards of mathematical practice and content and to the lamp?

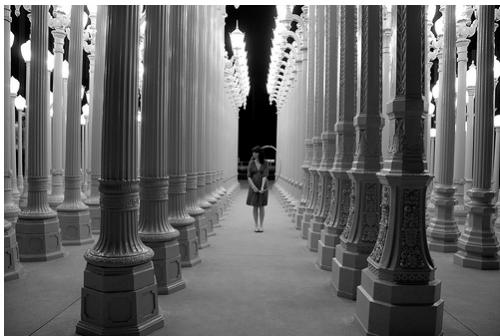
## Perspective

- Perspective is a system for representing 3-dimensional objects, viewed in spatial recession, on a 2-dimensional surface.
  - linear perspective
    - Linear perspective uses sets of implied lines called converging or orthogonal lines that move closer together in the apparent distance until they merge at an imaginary vanishing point in the horizon.

## Urban Light



Credit: <http://thegirlinla.blogspot.com/2009/03/lacma-urban-lights-collage.html>



<http://www.flickr.com/photos/ellipyyjenkins/3265315624/in/set-72157613525820996/>

## Urban Light Chris Burden, 2008



- Standards of Mathematical Practice:
  7. Look for and make use of structure.
  8. Look for and express regularity in repeated reasoning.
- 5th Grade
  - Operations & Algebraic Thinking
    - Analyze patterns and relationships
  - 3. Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms.
- High School: Building Functions:
  2. Write arithmetic and geometric functions both recursively and with an explicit formula. Use them to model situations and to translate between the two forms.

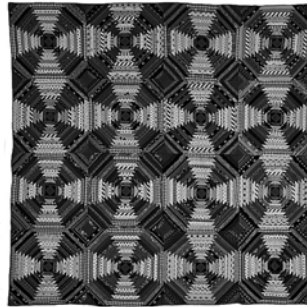
## Task 6



- Perspective makes the height of the rows of street lights seem to get smaller as we move to the back of the picture. If the initial heights are as given below, what could be the perceived height of the 20th light, if the lights went on to the vanishing point?
- 20', 18', 16.2', 14.58', 13.122',...

How is this problem connected to the standards of mathematical practice and content and to the lights?

## Proportion

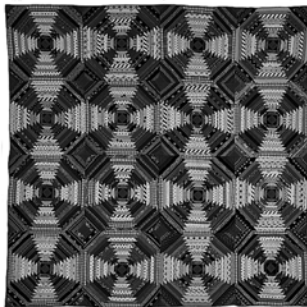


- In art, proportion is the principle of design concerned with the size relationships of parts of a composition to each other and to the whole.
- In math, proportion is the ratio or relation of one part or another to the whole with respect to size, quantity, and degree.
- Look carefully and consider the artist's use of proportion.

### U.S., Pennsylvania

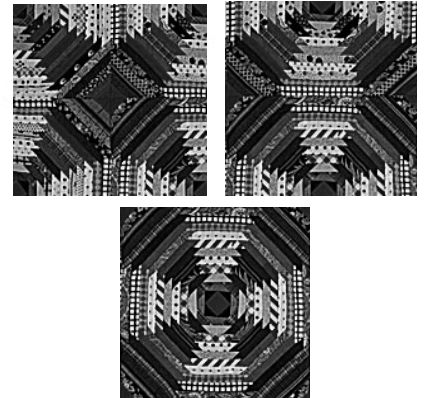
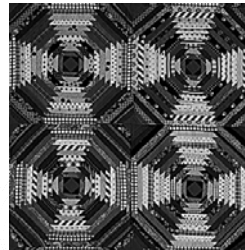
Quilt, 'Log Cabin' Pattern, 'Pineapple' variation, 1870-1880

- Standards of Mathematical Practice:
  5. use appropriate tools strategically
  6. Attend to precision
  7. Look for & make use of structure.
  8. Look for & express regularity in repeated reasoning.
- 6th Grade
  - Ratios & Proportional Reasoning
    3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.



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## □ Which Pattern?



## Task 7

- What percent of the design at the right is composed of the following pieces:
  - Large Circles
  - Truncated pyramids
    - Light
    - Dark
  - Octagons
  - Squares
  - Other shapes
- Hey, why does this add up to more than 100%?

How is this problem connected to the standards of mathematical practice and content and to the quilt?



## More Art & Math

Artistic & Mathematical Gems



## Geometry of the Kuba

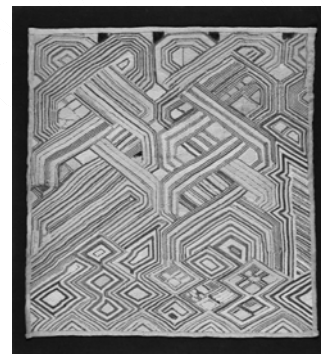


- Standards of Mathematical Practice:
  - Reason abstractly and quantitatively
  - Construct viable arguments and critique the reasoning of others.
- High School
  - Geometry
    - Prove geometric theorems
      - Prove theorems about lines and angles. Theorems include: when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent.

<http://lacma.wordpress.com/2011/03/16/geometry-of-the-kuba/>

## Geometry of the Kuba

- What task(s) do you see fitting here?



## Elizabeth Catlett, Sharecropper

- Standards of Mathematical Practice:
  - use appropriate tools strategically
  - Attend to precision
- Kindergarten
  - Geometry
    - Identify and describe shapes
      - describe objects in the environment using names of shapes, and describe the relative position of these objects.



<http://lacma.wordpress.com/2011/08/03/new-acquisition-elizabeth-catlett-sharecropper/>

## Elizabeth Catlett, Sharecropper

- What task(s) do you see fitting here?



## Mexico, Colima Vessel, 200 B.C. - A.D. 500

- Standards of Mathematical Practice:
  - 4: Model with mathematics
- 8th grade
  - Functions
    - Use functions to model relationships between quantities.
    - Describe qualitatively the functional relationship between two quantities by analyzing a graph. Sketch a graph that exhibits the qualitative features of a function that has been described verbally.



[http://collectionsonline.lacma.org/mwebcgi/mweb.exe?request=image;hex=M86\\_296\\_190.JPG](http://collectionsonline.lacma.org/mwebcgi/mweb.exe?request=image;hex=M86_296_190.JPG)

## Drum Hawaiian islands, c. 1760



- Standards of Mathematical Practice:
  - Look for and express regularity in repeated reasoning.
- High School
  - Functions
    - Trigonometric functions
      - Model periodic phenomena with trigonometric functions

<http://collectionsonline.lacma.org/mwebcgi/mweb.exe?request=record;id=175580;type=101>

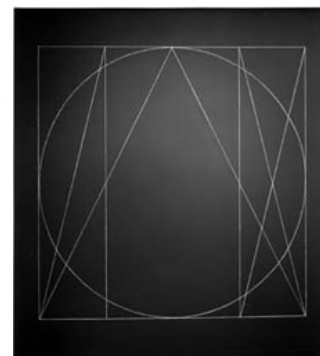
Foliated Platter (Pan) with the Eight Buddhist Symbols  
(Bajixiang), Flowers, and Waves,  
late Yuan dynasty, circa 1340-1368



- Standards of Mathematical Practice:
  - use appropriate tools strategically
  - Attend to precision
- High School
  - Geometry
    - Circles
      - Understand and apply theorems about circles.

<http://collectionsonline.lacma.org/mwebcgi/mweb.exe?request=record;id=19863;ty>

Sol LeWitt, Wall Drawing #295: Six Superimposed Geometric Figures

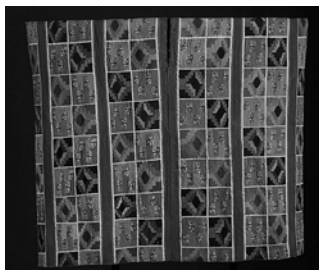


- Standards of Mathematical Practice:
  - Construct viable arguments and critique the reasoning of others
  - use appropriate tools strategically.
- High School
  - Geometry
    - Congruence
      - Prove geometric theorems

<http://www.lacma.org/beyondgeometry/artworks18.html>

Peru, South Coast,  
Wari Man's Tunic, 600-850

- Standards of Mathematical Practice:
  - Look for and express regularity in repeated reasoning.
- High School
  - Geometry Overview
    - Congruent
      - Experiment with transformations in the plane.



<http://collectionsonline.lacma.org/mwebcgi/mweb.exe?request=record;id=30745;ty>

## Conclusion

"The mathematician's patterns, like the painter's or the poet's must be beautiful; the ideas, like the colors or the words must fit together in a harmonious way. Beauty is the first test: there is no permanent place in this world for ugly mathematics." - G. H. Hardy (1877 - 1947), A Mathematician's Apology, Cambridge University Press, 1994.

## Conclusion

"Beauty depends on size as well as symmetry."  
- Aristotle (384 B.C.-322 B.C.), Poetics

## Conclusion

"Mathematics, as much as music or any other art, is one of the means by which we rise to a complete self-consciousness. The **significance** of Mathematics resides precisely in the fact that it is an art; by informing us of the nature of our own minds it informs us of much that depends on our minds." - J.W.N. Sullivan (1886-1937), Aspects of Science, 1925.

# When Am I Ever Going to Use This?

Depends on whom you  
become!